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ABSTRACT

The study sought to: (1) identify the determinants that motivate Hispanic-American students to enroll in high school chemistry; and (2) determine if providing belief-based information to students and their parents/guardians increases chemistry registration. The Theory of Planned Behavior (TPB) and Elaboration Likelihood Model (ELM) guided the study. Belief-based information about chemistry enrollment was collected from 69 students and was content analyzed. Once identified, the modal salient beliefs and referents guided development of the Chemistry Interest Questionnaire (CIQ), audiotaped messages, and accompanying information sheets. Messages were administered to one control and three experimental groups. One week later 598 students completed the CIQ. Shortly thereafter they registered for fall, 1990 courses. Findings support use of the TBP and ELM. Chemistry enrollment for students in the student only message group exceeded chance expectations. (24 references) (Author/KR)

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Hispanic-American Students' Attitudes Toward Enrolling in High School Chemistry: A Study of Planned Behavior and Belief-Based Change

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Abstract

The study sought to (a) identify the determinants that motivate Hispanic-American students to enroll in high school chemistry and (b) determine if providing belief-based information to students and their parents/guardians increases chemistry registration. The theory of planned behavior (TPB) and elaboration likelihood model (ELM) guided the study. Belief-based information about chemistry enrollment was collected from students (n = 69) and was content analyzed. Once identified, the modal salient beliefs and referents guided development of the Chemistry Interest Questionnaire (CIQ), audiotaped messages, and accompanying information sheets. Messages were administered to one control and three experimental groups. One week later students (N=598) completed the CIQ. Shortly thereafter they registered for Fall, 1990, courses. Findings support use of the TPB and ELM. Chemistry enrollment for students in the student only message group exceeded chance expectations.

Hispanic-American Students' Attitudes Toward Enrolling in High School Chemistry: A Study of Planned Behavior and Belief-Based Change

Precollege science education has come under scrutiny since 1980 when the National Science Foundation reported to President Carter that only about one-sixth of all secondary school students enrolled in junior- and senior-year courses in science and mathematics. Tenth-grade biology was reported to be the terminal course for most students not interested in pursuing careers in science, engineering, or in the health-related professions. Moreover, the dropout rate for science and mathematics at the tenth grade was found to be particularly severe for girls and minority students.

Nearly ten years later the National Science Foundation reported that the United States faced a shortage of scientists and engineers in the coming decade. The problem was exacerbated by two competing factors, an increased demand for persons to enter science, science-related, and technical careers and a dwindling supply of white male scientists. Calls were issued for all school personnel to broaden their traditional view of the white male scientist to include increased representation by minorities and women.

The broad goal of improved understanding of science and technology among all high school graduates is very closely tied to that of educating future scientists and engineers. Throughout the elementary and lower secondary grades no distinction is made between the science and mathematics education received by students who will enter the ranks of science- and engineering-bound collegians and the education received by persons who will pursue non-science occupations or professions. Once in the upper secondary grades, however, the educational programs of students pursuing academic, general, and vocational tracks sharply diverge. Students who intend to pursue a college education and career in science or engineering populate classes in chemistry, physics, calculus, and other advanced mathematics and science courses. General and vocational track students,

on the other hand, are more likely to study only the science and mathematics courses required for high school graduation.

Public attention is being directed to the plight of the Hispanic-American population. Termed the "... fastest-growing and least-educated minority group" in the May 30 issue of the Chronicle of Higher Education (Deloughry, 1990, p. A17), there are signs that the situation is unlikely to improve in the near future. The number of Mexican immigrants is on the rise, and these persons enter the Unites States with increasingly less schooling compared to the native-born population and other immigrants (Vernez & Ronfeldt, 1991). One only needs to examine the public school enrollment patterns in California, Texas, and Arizona to find firsthand evidence of the increased demands placed on education.

Hispanic-American students all too frequently are absent from the rolls of advanced mathematics and science courses in Texas' high schools, pursuing instead general and vocational programs of study or joining the ranks of high school dropouts. The dropout problem is particularly acute in Texas at a time when the state is in desperate need of a well-educated, highly skilled science and technology labor force. Key to developing and maintaining a potential pool of talented Texans, knowledgeable in science and technology, is to nurture and sustain the interest of Hispanic-American students' in the study of science and mathematics beyond the courses required for high school graduation. The key to improving education may lie in the untapped potential of the family, where familism is a core characteristic. Perceived family support has been found to be invariable despite changes in acculturation (Sabogal, Marin, & Otero-Sabogal, 1987).

What are the major determinants of Hispanic-American students' decision to enroll in an elective high school chemistry course? The search for an answer to this pressing question served to guide the research study undertaken in a school district serving a majority Hispanic-American community located in the Lower Rio Grande Valley, Texas,

during the Spring, 1990, prior to registration for courses to be taken in the Fall, 1990.

Purpose

This study examined Hispanic-American students' interest in enrolling in a key, high school elective science course, chemistry. The investigation sought answers to five questions from tenth grade students enrolled in biology in the sole high school in one school district located in the Lower Rio Grande Valley of Texas.

1. What are students' behavioral, normative, and control beliefs about the consequences of enrolling in chemistry?
2. Which variables external to the theory of planned behavior determine students' salient behavioral, normative, and control beliefs?
3. Which salient beliefs most influence formation of students' attitude, subjective norm, and perceived behavioral control about chemistry enrollment?
4. To what extent do attitude, subjective norm, and perceived behavioral control influence students' intention to enroll and actual enrollment in chemistry?
5. Will providing belief-based information to students and their parents/guardians that addresses students' concerns about chemistry enrollment result in more students registering to enroll in chemistry in the Fall, 1990?

Theoretical Base

The theory of planned behavior (Ajzen, 1985, 1988, 1989; Ajzen & Madden, 1986) provides a model for understanding the rational decision-making process and serves as the theoretical basis for asking the questions posed in this study. The model permits accurate prediction of behavior for situations in which people may have incomplete control over the decision to engage in the behavior, for example to begin a weight loss program within the next two weeks (Schifter & Ajzen, 1985). According to the theory, what a person does is determined by personal motivation; in turn, personal

motivation is determined by attitude, social support, and perceived behavioral control. Underlying these three factors is the individual's perception of the personal, social, and situational consequences of an action (i.e., the person's beliefs).

The authors of the TPB use specific terms to identify each of the variables included in the causal model. The five, directly measured outcomes of interest are referred to as:

1. behavior (B),
2. motivation to engage in a specific behavior, called behavioral intention (BI),
3. attitude toward engaging in the behavior (AB),
4. social support for engaging in the behavior, called subjective norm (SN), and
5. perceptions of individual control to act, called perceived behavioral control (PBC).

These variables are linked through the following equation:

$$B \sim BI \sim (AB + SN + PBC) = w_1AB + w_2SN + w_3PBC$$

where w_1, w_2, and w_3 represent the relative contributions of attitude, subjective norm, and perceived behavioral control, respectively, to the prediction of behavioral intention and subsequent behavior.

Information, in the form of beliefs, underlies the AB, SN, and PBC constructs. Attitude toward the behavior (AB) is a linear combination of the beliefs an individual holds about the consequence of engaging in the behavior of interest (b_i, for each of the i beliefs) weighted by the individual's evaluation (e_i) of each consequence (viz., $AB = \sum b_i e_i$, for each of the i beliefs). Likewise, subjective norm (SN) results from beliefs that each significant person wants the individual to perform the behavior (nb_J, for each of the J beliefs) weighted by the individual's motivation to comply (mc_J) with the wishes of each person (viz., $SN = \sum(nb)_J(mc)_J$, for each of the J referents). Similarly, perceived behavioral control (PBC) is a linear combination of an individual's beliefs about the factors that control performance of the behavior (cb_k, for each of the k

beliefs) weighted by the importance (ec_k) of each of the factors (PBC = $\Sigma(cb)_k(ec)_k$, for each of the k beliefs).

Since the introduction of the theory of reasoned action (TRA), a precursor to the theory of planned behavior, by Fishbein and Ajzen in 1975, interest in attitudinal studies in science education has been piqued. Attitude has been shown to be correlated with intent to engage in a specific science related behavior, viz., using hands-on science activities (Koballa, 1986), provided each variable is measured at the same level of specificity. This finding removed some of the mystery surrounding the attitude-behavior link and provided compelling evidence for abandoning further attempts to predict specific science-related behaviors using global measures of science-related attitudes and interests. Moreover, using highly specific measures as proposed by Ajzen and Fishbein (1980), science education researchers have shown that attitude and subjective norm are predictive of (a) students' intentions to study science (Stead, 1985), (b) middle school students' intentions to enroll in a high school science course (Crawley & Coe, 1990), (c) female students' intentions to enroll in at least one elective, high school physical science course (Koballa, 1988), and (d) grades 3 to 8 students' intentions to perform laboratory and non-laboratory science activities (Ray, 1989).

The TPB model was proposed to overcome a major criticism leveled at the TRA. Liska (1984) argued that most behaviors of interest is neither volitional nor involitional, but ranges from behavior which requires little skill and social cooperation to behavior which requires considerable skill, considerable social cooperation, or both. The TPB adds a third construct to the original TRA model, perceived behavioral control, which has a direct, independent contribution to the formation of behavioral intention. Crawley (1990) used the TPB model to examine the intentions of science teachers to use investigative teaching methods and found that attitude, subjective norm and perceived

behavioral control accounted for 28% ($p = .0007$) of the variance in teachers' intentions. The strong empirical link which has consistently been shown to exist between behavioral intention and (a) the perceived advantages and disadvantages for engaging in a specific behavior, (b) social support for doing so, and (c) perceptions of behavioral control has helped to establish the TPB as the foremost model for identifying and examining the motivational bases for engaging in specific science-related behaviors.

Application of the theories of reasoned action or planned behavior helps to identify salient beliefs for use in constructing persuasive messages. Persuasive messages bring about changes in behavior by providing information related to the salient beliefs of the target group. The information ultimately brings about changes in behavior by (a) changing behavioral, normative, and control beliefs; (b) their weighting factors; or (c) both. These shifts result in changes in attitude, subjective norm, and perceived behavioral control. Changes in one or more of these constructs will affect behavioral intention only to the extent that attitude, subjective norm, and perceived behavioral control carry a significant weight in the prediction of intention. The degree to which an intention change will cause a behavioral change is determined by the correspondence between intention and behavior.

In 1984 Stutman and Newell proposed a plan for constructing persuasive messages that extended the working of Fishbein and Ajzen. Critical elements of successful persuasive appeals to change specific behaviors are the specific beliefs of the target audience rather than societal and cultural values.

The elaboration likelihood model (ELM) of Petty and Cacioppo (1986) has contributed greatly to an understanding of how people are persuaded when messages are encountered. The extent to which recipients of persuasive appeals examine a message falls somewhere along a continuum, anchored at one end by a central processing route to persuasion and at the other by a central route. Persons who carefully scrutinize the

message arguments are said to be using the central route, according to Petty and Cacioppo; whereas persons who process message arguments in a biased manner and rely mostly on external cues use the peripheral route. People are motivated to hold beliefs that are seen to be beneficial, according to the ELM, and considerable variability exists regarding the kind and amount of issue-relevant elaboration that people are willing to engage in to evaluate a persuasive message. As peripheral cues become less important, issue-relevant processing is enhanced. The increased cognitive activity that occurs with issue-relevant or central processing produces greater resistance to counter-arguments and improved correspondence between attitude and behavior (Petty & Cacioppo, 1886).

Five motivational and ability variables determine the degree to which people scrutinize issue-relevant arguments. These factors include: (a) personal relevance, (b) number of message sources, (c) number of persons evaluating the message arguments, (d) prior knowledge, and (e) the message recipient's need for cognition (Petty & Cacioppo, 1986). Need for cognition addresses the desire a person has to experience an integrated and meaningful world (Cohen, Stotland, & Wolf, 1955) and embraces behaviors that, according to Petty and Cacioppo (1986), cannot be explained as drives or instincts.

The TPB and the ELM provide researchers with a conceptual framework for developing and conducting successful behavioral change studies. The intervention strategy is designed to develop one or more favorable attitude-behavior (A-B) outcomes among members of a target group. The strategy consists of six steps (Crawley & Koballa, 1991):

1. specifying the target behavior,
2. determining the salient beliefs of the target group,
3. designing the A-B questionnaire,
4. developing the persuasive message,

5. conducting the intervention program, and
6. assessing the A-B outcomes.

Methodology

Subjects

Participants in this study were biology students (N = 598), most of whom were in grade 10 (82%) and resided in the Lower Rio Grande Valley. Forty-four percent of the students were classified as "migrant", and more students were female (n = 297) than male (n = 287). Hispanic-Americans (n = 556) outnumbered students who were White, Non-Hispanic (n = 17), African-American (n = 4), Asian-American (n = 8), or "other" (n = 10). Students also provided information about their educational goals. Most students indicated that they planned to graduate from college (n = 320), but some planned to attend college for a while (n = 37), complete high school and go to technical school (n = 122), complete high school then work (n = 104), or leave high school to work (n = 12). Considerable variation was noted in their career aspirations. Some students sought a career in military service (n = 82), but others preferred a nonscience service job (n = 113), a science-related service job (n = 46), or a chemistry-related service job (n = 15). Most students wanted to pursue a profession, either in a nonscience field (n = 174) or a science-related field (n = 144). Only a few students aspired to a chemistry-related profession (n = 20).

Design

The project consisted of six steps (Crawley & Koballa, 1991) carried out over the latter part of the Fall Semester, 1989, and the early part of the Spring Semester, 1990. Open-ended (Chemistry Interest Survey, CIS), and closed-ended (Chemistry Interest Questionnaire, CIQ) questionnaires were developed for the target behavior and administered during the fall and spring semesters, respectively. Approximately 70 students completed the CIS in the late Fall Semester, 1989. Of all the students enrolled

in 10th grade biology classes 598 students (4 classes from each of 6 teachers) responded to the CIQ in the early Spring Semester, 1990.

Teachers were randomly selected to participate in the study, and classes were randomly assigned to experimental and control groups, two from each of the six teachers. Teachers were unaware of the exact nature of the intervention being tested with their classes. Two of the four classes of each teacher served as control classes, to monitor a teacher's unintentional use of the intervention with control classes. The intervention consisted of two classes testing the effects of the questionnaire-as-message; two classes testing the effects of student only message, and two classes testing the effects of student and parent/guardian messages.

Variables

Both external and model variables were examined in this study. Gender, ethnicity, educational goal, and career goal were the external variables included in the study. Inclusion of these four variables in the study is justified on the basis of past attitude-related research in science education (Ormerod & Duckworth, 1975) which has documented their association with constructs central to the theory of planned behavior. All total, the eight TPB model variables included in this study were: (a) attitude and its belief-based estimate, (b) subjective norm and its belief-based estimate, (c) perceived behavioral control and its belief-based estimate, (d) behavioral intention, and (e) behavior.

The target behavior presented to students in this study was "signing-up in March on the course-choice form to take Chemistry in September, 1990." The behavior is specific and contains the four, essential elements specified by Ajzen and Fishbein (1980): (a) action (signing-up), (b) target (Chemistry), (c) context (implied to be during pre-registration period), and (d) time (in March, 1990). To save space and reading time students were told that the statement would be shortened to read "signing-

up to take Chemistry in September, 1990," with the implied context component, during the upcoming pre-registration period.

Questionnaire Design

A representative sample of students was questioned about their behavioral, normative, and control beliefs, using the CIS. Specifically, they were asked to list (a) the advantages and disadvantages of enrolling in high school chemistry (behavioral beliefs), (b) the persons who would be approve or disapprove of chemistry enrollment (normative beliefs), and (c) factors that facilitate or inhibit their enrolling in chemistry (control beliefs).

Belief data were content-analyzed to arrive at modal salient beliefs, accounting for 90% of the beliefs identified on the CIS. Content analysis is a process by which belief statements are read, grouped according to topic, rewritten and/or regrouped if necessary, and reduced to the fewest number of statements. The wording and phrasing for the final belief statements (and referents) was made clear and concise yet similar in tone to the unedited responses supplied by students. Six behavioral beliefs, five normative beliefs, and seven control beliefs about engaging in the target behavior were identified from data gathered from the CIS. Support for the content validity of the belief statements comprising attitudinal, normative, and control constructs was evidenced from their similarity with belief statements identified in published studies (Crawley & Coe, 1990; Koballa, 1988; Crawley, in press). Construct validity was evidenced through the significant intercorrelations of the direct measures of the four model variables, as specified in the theory of planned behavior. Moreover, belief -based estimates of attitude, subjective norm, and perceived behavioral control were found to be valid antecedents of the three model variables. In previous checks on the reliability of the instrument's four constructs, test-retest correlation coefficients were found to be

acceptable: .72 for intention, .70 for attitude, .50 for subjective norm, and .58 for perceived behavioral control (Black, 1990; Coleman, Koballa, & Crawley, in press).

The final questionnaire provided information on each of the four external and seven model variables. A 7-point, bipolar adjective scale, anchored by the adjectives likely and unlikely was used to measure behavioral intention (BI). A direct measure of attitude toward the behavior (AB) was obtained by summing students' responses to each of four, 7-point, bipolar, evaluative adjective-pairs. Indirect or belief-based estimates of attitude were obtained by summing the products of behavioral belief and the corresponding evaluation of outcome statements, for each of the six beliefs. Likewise, direct and indirect measures of subjective norm (SN) and perceived behavioral control (PBC) were measured.

Data Analyses Techniques

A four-stage causal modeling methodology (Pedhazur, 1982) was used to test the contribution of the four external and seven model variables to the prediction of behavior, as specified in the theory of planned behavior. The method of path analysis was employed to test the direct effects of external variables (gender, ethnicity, educational goal, and career goal) on belief-based estimates of TPB model variables (behavioral, normative, and control beliefs) in stage 1 of the analysis. Stage 2 of the analysis tested the direct contribution of belief-based estimates of attitude, subjective norm, and perceived behavioral control to the three direct measures of these model variables. In the last two steps the contribution of the direct measures of attitude, subjective norm, and perceived behavioral control to behavioral intention (stage 3) were analyzed, and, in turn, the importance of behavioral intention to the prediction of behavior (stage 4) was determined. Steps 1-4 test causal relations that are hypothesized in the theory of planned behavior. Lacking a theoretical justification within the TPB, no attempt was made to analyze and explain any of the interrelationships

that might exist among the four external variables, among students' beliefs (behavioral, normative, control), or among direct measures of the TPB constructs.

Theory trimming was employed with external and model variables (Pedhazur, 1982, p. 616-617). This decision was justified on theoretical and practical grounds. The TPB does not specify the exact nature of the relationship between specific external variables and beliefs, only that interpersonal differences give rise to differences in beliefs (Ajzen & Fishbein, 1980, p. 82-83). Moreover, trimming variables that make nonsignificant contributions to model effects at this stage of analysis permits exploration of the four cause-effect links in the TPB model: (a) the underlying causes of differences in students' beliefs due to external variables; (b) the beliefs that bring about differences in attitude, subjective norm, and perceived behavioral control; (c) the effects of the three motivational constructs on behavioral intention; and (d) the contribution of behavioral intention to behavior, viz., chemistry registration.

Findings are presented in the same order as the research questions were posed. Questions posed in this study were answered through the use of three statistical analysis techniques: multiple regression, stepwise regression, and analysis of variance.

Message Construction and Intervention

Messages consisted of information that addressed salient beliefs provided by students on the CIS. Information presented in the messages reinforced favorable attribute-behavior links and either downplayed or discredited unfavorable links that students held about signing-up for chemistry in the Fall, 1990. Attributes consisted of specific outcomes, referents, or controls associated with engaging in the behavior, viz., signing-up for chemistry. Outcome-behavior links are called behavioral beliefs; referent-behavior links, normative beliefs; and control-behavior links, control beliefs. Messages sent home to parents/guardians were printed in English and Spanish. Following the treatment all 24 classes responded to the Chemistry Interest

Questionnaire (CIQ), which consisted of 50 items. The data collection phase of the project concluded with registration for Fall, 1990, courses, which took place in March, 1990.

Findings of the Study

Modal Salient Beliefs

There were 69 students who responded to the CIS in the late Fall Semester, 1989, mostly 10th graders all of whom were enrolled in biology at the time. Students identified six consequences associated with enrolling in chemistry in Fall, 1990. They believed that enrolling in chemistry would result in the following advantages:

1. help them reach their educational goals,
2. help them attain their career goals,
3. increase their knowledge of chemistry, and
4. mean studying topics that are interesting.

Students identified two disadvantages:

1. do more work at home and at school, and
2. possibly get low grades.

In addition, students recognized several persons and groups that impact their decision to enroll in chemistry. The persons and groups included:

1. parents and/or guardians,
2. brothers and/or sisters,
3. the biology teacher,
4. friends, and
5. the counselor.

To a great extent students realized that enrolling in chemistry involved more than personal interest and support from other people. Six beliefs about factors outside the

students' control were identified that could prevent them from enrolling in chemistry. The conflicts that students associated with enrolling in chemistry included:

1. having weak grades in math classes,
2. working in an after-school job that would interfere with study time,
3. participating in after-school activities such as sports, band or school clubs that may interfere with study time,
4. having a conflict with a course that they wanted or needed to take,
5. speaking a first language other than English, and
6. failing the Preassessment of Math Skills for Chemistry test.

The math test has been used by the school to screen students who want to take chemistry. One facilitating factor was identified. Enrollment will be made easier, according to students, if the chemistry course were offered at 7:00 a.m.

External and Model Variable Relationships

Questionnaire results indicated that students held somewhat favorable behavioral, normative, and control beliefs about signing-up for chemistry, although considerable variation was evidenced. Attitude and subjective norm scores were moderately favorable also. On average, students tended to believe that the decision to sign-up for chemistry was theirs to make, but there was considerable variation. Overall, intention to sign-up for chemistry was somewhat favorable but varied considerably among students. Descriptive results for the TPB model variables are summarized in Table 1.

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Insert Table 1 about here

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Which variables external to the TPB model determine students' behavioral, normative, and control beliefs? This question was answered in stage 1 of the analysis by determining the path coefficients from external to belief-based estimates of TPB

variables. Educational (β = .16, p = .0002) and career (β = .11, p = .0120) goals were determined to be the sole predictors of students' behavioral beliefs about signing-up for chemistry, which accounted for 5 % of the variance in belief scores. Differences in normative beliefs about chemistry sign-up were attributed to differences in students' career goals only (β = .11, p = .0112). Career-goal differences accounted for 2% of the variance in students' normative beliefs. Students' control beliefs were not affected by any of the four external variables examined in this study.

The relationships between behavioral, normative, and control beliefs and attitude, subjective norm, and perceived behavioral control, respectively, were determined in stage 2 of the data analyses. All behavioral beliefs were found to contribute to the formation of attitude and accounted for 49% of the total variance in attitude scores. Students believed that signing-up for chemistry would: (a) help them attain their educational goals (β = .23, p = .0001), (b) mean that they would study interesting topics (β = .22, p = .0001), (c) help them attain their career goals (β = .20, p = .0001), (d) mean that they would learn useful information (β = .15, p = .0001), (e) possibly get low grades (β = .16, p = .0001), and (f) result in more work at home and at school (β = .07, p = .0225). Three groups of individuals were perceived to be supportive of students' signing-up for chemistry, accounting for 23% of the total variance. These included the (a) counselor (β = .23, p = .0001), (b) parents or guardians (β = .20, p = .0001), and (c) friends (β = .15, p = .0005). Three beliefs helped to determine students' perception of control about signing-up for chemistry, accounting for 3% of the total variance. One facilitative factor was identified, offering chemistry at 7:00 am (β = .14, p = .0012), and two inhibitive factors were revealed, speaking a first language other than English (β = .09, p = .0435) and having weak grades in math (β = -.09, p = .0435).

Path coefficients were determined: (a) from attitude, subjective norm, and perceived behavioral control to behavioral intention, (b) from behavioral intention and perceived behavioral control to behavior, and (c) from behavioral intention alone to behavior. Results of stage 3 analyses identified contributions from attitude (β = .67, p = .0001) and perceived behavioral control (β = .06, p = .0474) to the prediction of behavioral intention. Both constructs accounted for 48% of the variance in intention. It was determined that subjective norm did not influence intention to sign-up for chemistry (β = .03, p = .2709). Moreover, behavioral prediction was not aided when behavioral intention (β = .30, p = .0001) and perceived behavioral control (β = .05, p = .1863) were considered collectively. Behavioral intention alone accounted for 10% of the variance in behavior (β = .32, p = .0001).

Path coefficients were identified for the trimmed TPB model. External variables accounted for 5% of the variability in behavioral beliefs and 2% in normative beliefs. The belief antecedents accounted for 49% of the variability in attitude scores, 24% of subjective norm scores, and 4% of the score variability for perceived behavioral control. Attitude and perceived behavioral control in combination accounted for 48% of the variability in behavioral intention, and intention accounted for 10% of the variability in behavior. Path coefficients for the trimmed TPB model are presented in Table 2.

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Insert Table 2 about here

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Behavioral Intervention

According to the TPB model changes in behavior are due to changes in personal motivation which, in turn, is caused by changes in personal attitude, social support, and/or perceptions of control over the decision. Changes in each of the three sources of

motivation result from changes in underlying beliefs. Consequently, changes in beliefs bring about changes in motivation, which ultimately effects behavior. This investigation sought to change tenth grade students' behavior, namely "signing-up for chemistry", by changing the beliefs students held about enrolling in chemistry.

What impact did the intervention (a persuasive message directed to students only or to students and their parents) have on chemistry enrollment? Results of statistical analyses proved to be significant [χ^2 (3, N = 584) = 15.85, p = .0012]. Actual chemistry enrollment exceeded expected numbers for students in the student only message group (n = 20 vs. n = 11), underestimated expected enrollment in the questionnaire-as-message group (n = 2 vs. n = 11), and was in line with expected values in the student and parent/guardian (n = 15 vs. n = 14) and control (n = 23 vs. n = 24) message groups.

Changes in enrollment were brought about by changes in students' intentions [F(3,581) = 4.65, p = .0032] but in unexpected ways. Follow-up tests revealed that students in the student only and control message groups registered greater behavioral intention scores than did students in the student and parent/guardian message or questionnaire-as-message groups. The difference between the student only message and control groups proved not to be significant.

Differences were detected in attitude toward signing-up for chemistry [F(3,581) = 6.53, p = .0002] but not for perceived behavioral control [F(3,572) = 0.79, p = .4978]. Students in the student only message group were found to have registered more favorable attitudes than did their counterparts in the student and parent/guardian message or control groups. Attitude differences did not arise, it was determined, due to differences among groups' belief-based attitudes [F(3,581) = 1.95, p = .1198]. Differences in belief-based measures of perceived behavioral control, however, were detected among groups [F(3,575) = 3.00, p = .0300]. Though differences tended to

favor the student-only message group, the differences proved not to be significant using a conservative follow-up test.

Discussion and Recommendations

Hispanic-American students' intentions directly affect their decision to sign-up for chemistry. Students who intend to sign-up for chemistry are motivated to do so because they hold favorable attitudes toward chemistry enrollment. Support from other people does not have a significant impact on their intentions. Somewhat influential in determining their motivation is students' sense of control over the decision to sign-up for chemistry. Primary among the control factors, according to students, are the need to offer chemistry at 7 a.m. in the morning to avoid possible time conflicts, speaking a first language other than English (viz., Spanish), and weaknesses in math.

Use of the belief-based message had a significant impact on students' decision to sign-up for chemistry in the Fall, 1990, but in unanticipated ways. Providing only students, not students and their parents/guardians, with information about signing-up for chemistry tends to increase enrollment because, it can be concluded, they are made more aware of the advantages for doing so by their biology teachers, acquire favorable attitudes, and act accordingly. On the other hand, providing students and their parents/guardians with the same information reduces interest in taking chemistry and results in lower-than-expected chemistry enrollment.

What conclusions can be drawn from the results of this study? Hispanic-American students in Texas who decide to sign-up for chemistry appear to be independent-minded. In reaching a decision, they rely on their attitude, not on what other people want them to do. To some extent they also are influenced by personal perceptions of control over the decision process and by the external barriers that they perceive to exist.

Two explanations might help to explain the lower-than-expected chemistry registration among students who, along with their parents/guardians, were provided

with information about enrolling in chemistry. First, parents may have offered their sons/daughters counterarguments that stressed the (a) disadvantages of signing-up for chemistry, (b) advantages of not signing-up for chemistry (or both), or (c) lack of chemistry-related job opportunities in the Lower Rio Grande Valley. Many of these adults may lack an understanding of chemistry. Furthermore, they may have little or no information about opportunities in higher education for Hispanic-Americans who are interested in chemistry, or the many chemistry-related job opportunities throughout Texas that are available to persons who have studied chemistry in high school and college. Second, students may believe that the decision to sign-up for chemistry is a highly personal one, a decision that they alone must make, and they may have resented being asked to inform and discuss this decision with their parents/guardians. A combination of both explanations and/or additional factors may have operated to lower interest in the study of chemistry among students who discussed the decision with their parents/guardians.

Additional research is needed to explore the actual and potential roles the Hispanic-American family plays in educational decisions. The strong sense of family support may hold great potential for helping secure greater commitment from Hispanic-American students to study advanced science (and mathematics) courses. The counterintuitive finding of this study that providing parents and their sons/daughters with information about chemistry enrollment resulted in a lower-than-expected sign-up rate may be unique to the rural school district in which the study was conducted. More information is needed about course selection decisions among Hispanic-American students residing in urban as well as rural settings.

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Table 1

Descriptive Results for Model Variables

Outcome	M	SD	Actual Range	Possible Range
$\Sigma_{1\text{-}6} b_i e_i$	13.80	18.05	-45 to +54	-54 to +54
$\Sigma_{1\text{-}5} (nb)_J (mc)_J$	7.95	13.35	-36 to +45	-45 to +45
$\Sigma_{1\text{-}7} (cb)_k (ec)_k$	3.86	14.32	-39 to +63	-63 to +63
AB	2.77	5.28	-12 to +12	-12 to +12
SN	1.54	3.89	-9 to +9	-9 to +9
PBC	2.20	4.25	-9 to +9	-9 to +9
BI	0.52	1.87	-3 to +3	-3 to +3

Note. b = behavioral beliefs; e = outcome evaluation; nb = normative beliefs; mc = motivation to comply; cb = control beliefs; ec = evaluation of controls; AB = attitude toward the behavior; SN = subjective norm; PBC = perceived behavioral control; BI = behavioral intention.

Table 2

Summary of Path Coefficients — Trimmed Model

Effect	Cause	Beta	p	adjR^2
Behavioral beliefs	Educational goal	.17	.0002	___
	Career goal	.11	.0096	.05
Normative beliefs	Career goal	.14	.0007	
Attitude toward behavior	Attain educational goals	.23	.0001	___
	Attain career goals	.20	.0001	___
	Study interesting topics	.22	.0001	___
	Have more work to do	.07	.0225	___
	Learn useful information	.15	.0001	___
	Get low grades	.16	.0001	.49
Subjective norm	Counselor	.23	.0001	___
	Parents/Guardians	.23	.0001	___
	Friends	.16	.0001	.24
Perceived behavioral control	Offer chemistry at 7:00 am	.15	.0003	___
	Speak Spanish	.08	.0529	___
	Have weak math grades	.10	.0196	.04
Behavioral intention	Attitude toward behavior	.67	.0001	___
	Perceived behavioral control	.06	.0445	.48
Behavior	Behavioral intention	.32	.0001	.10

Note. Change in effect variance resulting from trimming was insignificant.

Table 3

Descriptive Results of Intervention Effects (M/SD)

Trimmed Outcome	Message Groups: Students/Parents (n = 135)	Students (n = 111)	Questionnaire (n = 109)	Control (n = 224)
BI	0.15/1.97	0.78/1.91	0.21/1.73	0.73/1.78
PBC	2.34/4.38	2.66/4.08	2.11/3.79	1.93/4.40
AB	2.78/5.30	4.55/4.76	1.52/4.62	2.56/5.60
$\Sigma b_i e_i$	13.64/16.77	17.26/18.04	11.70/17.71	13.26/18.57
$\Sigma(cb)_k(ec)_k$	3.70/14.44	7.42/17.72	2.27/10.34	3.04/14.03

Table 4

Intervention Effects on Trimmed Model Variables

Outcome	Source	SS	df	MS	F	p
BI	Between	47.36	3	15.79	4.65	.0032
	Within	1970.82	581	3.39		
PBC	Between	42.58	3	14.19	0.79	.4978
	Within	10229.64	572	17.88		
AB	Between	530.73	3	176.91	6.53	.0002
	Within	15744.65	581	27.10		
$\Sigma b_i e_i$	Between	1880.61	3	626.87	1.95	.1198
	Within	186394.19	581	320.82		
$\Sigma(cb)_k(ec)_k$	Between	1834.82	3	611.61	3.00	.0300
	Within	117066.54	575	203.59		